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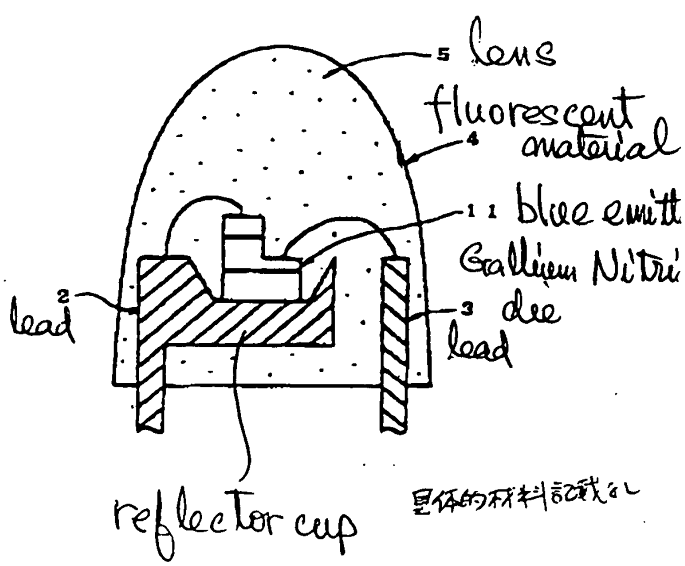
(71)出願人　000226057
日亜化学工業株式会社
徳島県阿南市上中町岡491番地100

(72)発明者　多田津　芳昭
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

(72)発明者　中村　修二
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

(54)【発明の名称】　発光ダイオード

(57)【要約】
【目的】　発光ピークが430nm付近、および370nm付近にある窒化ガリウム系化合物半導体材料よりなる発光素子を有する発光ダイオードの視感度を良くし、またその輝度を向上させる。
【構成】　ステム上に発光素子を有し、それを樹脂モールドで包囲してなる発光ダイオードにおいて、前記発光素子が、一般式$Ga_XAl_{1-X}N$（但し$0 \leq X \leq 1$である）で表される窒化ガリウム系化合物半導体よりなり、さらに前記樹脂モールド中に、前記窒化ガリウム系化合物半導体の発光により励起されて蛍光を発する蛍光染料、または蛍光顔料が添加されてなる発光ダイオード。



５．ＵＳＰ５，８４７，５０７

出願日：'97.7.14

名称：発光ダイオードレンズ用の蛍光染料が加えられたエポキシ樹脂。

課題：蛍光体含有層を形成することなく、また、無機蛍光体から放出された光が無機蛍光体粒子によって光の取り出しが妨げられることのない発光ダイオードを提供する。

解決手段：

１．第一の波長の光を放出する光放出素子と、光源から放出される光を収束するためのレンズと、レンズに含有された第一の波長を吸収して第二の波長の光を再放射する非散乱蛍光材料からなる光源

２．クレーム１において、レンズ中の蛍光材料の濃度は、レンズの特定領域内であって再放射が起こる重要な領域であり、再放射された光がレンズによって収束される。

３．クレーム１において、蛍光材料は有機染料。

４．クレーム１において、第一の波長の光を吸収し、第三の波長の光を再放出する第二の蛍光材料を含んでいる。

５．クレーム１において、第二の波長の光を吸収し、第三の波長の光を再放出する第二の蛍光材料を含んでいる。

６．クレーム１において、光放出素子は発光ダイオードである。

７．クレーム１において、光放出素子はレーザーダイオードである。

８．光源の形成方法であって、光放出素子から第一の波長を放出し、レンズは光源から放出された光を収束する。

レンズに含まれた非散乱蛍光材料は第一の波長の光を吸収し、第二の波長の光を放出する。

９．クレーム８において、レンズ中の蛍光材料の濃度は、レンズの特定領域内であって再放射が起こる重要な領域であり、再放射された光がレンズによって収束される。

１０．クレーム８において、蛍光材料は有機染料。

１１．クレーム８において、第一の波長の光を吸収し、第三の波長の光を再放出する第二の蛍光材料を含んでいる。

１２．クレーム８において、第二の波長の光を吸収し、第三の波長の光を再放出する第二の蛍光材料を含んでいる。

１３．クレーム８において、光放出素子は発光ダイオードである。

１４．クレーム８において、光放出素子はレーザーダイオードである。

１５．以下の構成からなる光源

第一の波長の光を放出するための光放出手段、光源から放出される光を収束するための収束手段、収束手段には第一の波長の光を吸収し、第二の波長の光を再照射するための非散乱蛍光手段が含有されている。

１６．クレーム１５において、収束手段中の蛍光材料の濃度は、レンズの特定領域内で

あって再放射が起こる重要な領域であり、再放射された光が収束手段によって収束される。

１７．クレーム１５において、蛍光材料は有機染料。

１８．クレーム１５において、第一の波長の光を吸収し、第三の波長の光を再放出する第二の蛍光材料を含んでいる。

１９．クレーム１５において、第二の波長の光を吸収し、第三の波長の光を再放出する第二の蛍光材料を含んでいる。

２０．クレーム１５において、光放出素子は発光ダイオードである。

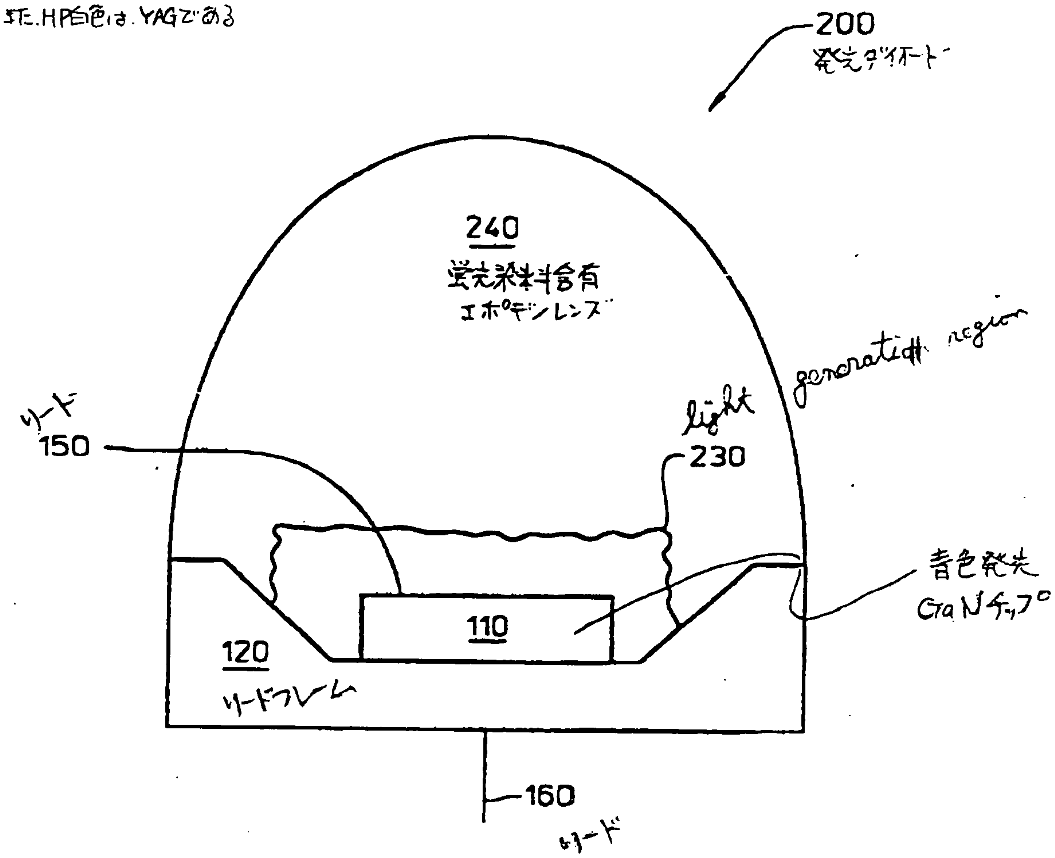
２１．クレーム１５において、光放出素子はレーザーダイオードである。

その他：出願時点で「ＧａＮ青色ＬＥＤとＣｅ：ＹＡＧとを利用した白色ＬＥＤがＮＩＣＨＩＡによって製造されている」旨がカラム１第３１行から同第４４行に記載されている。

即ち、日亜製の白色ＬＥＤを対象としていない。また、この特許の現クレームでは日亜の蛍光染料＋ＬＥＤ（特開平 5-152609 号）と差別化されていない。— 審判係属中

non-scattering の例として有機蛍光体しか開示されておらず。ＹＡＧ蛍光体と non-scattering となる屈折率を持った透光性封止樹脂は実質ないと考えられる。従って、白色ＬＥＤにおいて今後も問題となることはない。明細書中の記載を何か限定させたとしても実質日亜の現製品とは関係ない。なお、日亜白色ＬＥＤは米国に遅くとも'96.10.25 までに出荷している。

また、HP白色は、YAGである



(5-152609)

(54) [Title of the Invention] LIGHT-EMITTING DIODE

(57) [Abstract]

[Purpose] To provide a better visibility and to improve the brightness of a light-emitting diode having a light-emitting element made of a gallium nitride compound semiconductor material with light emission peaks at around 430 nm and at around 370 nm.

[Construction] A light-emitting diode having a light-emitting element disposed on a stem and covered by a resin mold, wherein said light-emitting element is made of a gallium nitride compound semiconductor represented by a general formula of $Ga_XAl_{1-X}N$ ($0 \leq X \leq 1$), and a fluorescent dye or a fluorescent pigment that emits fluorescence by being excited with light emission of said gallium nitride compound semiconductor is added into said resin mold.

[Claims]

[Claim 1] A light-emitting diode having a light-emitting element disposed on a stem and covered by a resin mold, characterized in that said light-emitting element is made of a gallium nitride compound semiconductor represented by the general formula of $Ga_XAl_{1-X}N$ ($0 \leq X \leq 1$), and a fluorescent dye or a fluorescent pigment that emits fluorescence by being excited with light emission of said gallium nitride compound semiconductor is added into said resin mold.

[Detailed Description of the Invention]

[0001]

[Industrially Applicable Field] The present device relates to a light-emitting diode (hereafter referred to as LED) obtained by covering a light-emitting element with a resin mold, and more particularly to a wavelength-converting light-emitting diode capable of various kinds of light emission with one kind of a light-emitting element and further

having a high brightness.

[0002]

[Prior Art] Generally, a LED has a structure shown in FIG. 1. There are shown a light-emitting element 1 cut out to be 1 mm square or less and made, for example, of GaAlAs or GaP, a metal stem 2, a metal post 3, and a resin mold 4 covering the light-emitting element. A back surface electrode of the light-emitting element 1 is bonded to and electrically connected to the metal stem 2 with a silver paste or the like; the front surface electrode of the light-emitting element 1 is wire-bonded on its surface by means of a gold wire extending from the metal post 3 serving as the other terminal; and the light-emitting element 1 is molded with a transparent resin mold 4.

[0003] Typically, a resin having a high refractive index and having a high transparency is selected as the resin mold 4 for the purpose of efficiently releasing the emitted light of the light-emitting element into air. In addition, however, an inorganic pigment or an organic pigment is mixed as a coloring agent into the resin mold 4 in some cases for the purpose of converting the emission color of the light-emitting element or for the purpose of correcting the color. For example, a white emission color can be obtained by adding a red pigment into a resin mold of a green light-emitting element having a GaP semiconductor material.

[0004]

[Problems to be Solved by the Invention] However, a technique of converting the wavelength by adding a coloring agent into a resin mold has not been put into practical use, and only the technique of correcting the color by a coloring agent is used. This is because, if a coloring agent which is a non-light-emitting substance capable of converting the wavelength is added to the resin mold, the brightness of the LED itself is greatly reduced.

[0005] In the meantime, the LEDs having infrared, red, yellow, or green light emission,

are currently in practical use, while blue or ultraviolet LEDs are not yet in practical use. A study of light-emitting elements of blue or ultraviolet light emission is conducted using a semiconductor material such as ZnSe of II-VI group, SiC of IV-IV group, or a GaN of III-V group. Among these, a gallium nitride compound semiconductor represented by the general formula of $Ga_XAl_{1-X}N$ ($0 \leq X \leq 1$) is recently reported to produce a comparatively excellent light emission at an ordinary temperature and is attracting people's attention. Also, a LED is reported which has realized a pn junction for the first time by using a gallium nitride compound semiconductor (Applied Physics, Vol. 60, No. 2, pp. 163-166, 1991). According to this report, the LED having a gallium nitride compound semiconductor with a pn junction has a light emission wavelength mainly at around 430 nm, and also has a light emission peak in an ultraviolet region around 370 nm. This wavelength is the shortest wavelength among the above-mentioned semiconductor materials. However, the LED has a disadvantage of poor visibility because the LED has a light emission color near to violet color as shown by its light emission wavelength.

[0006] The present invention has been made in view of these circumstances and the purpose thereof is to provide a better visibility and to improve the brightness of a LED having a light-emitting element made of a gallium nitride compound semiconductor material with light emission peaks at around 430 nm and 370 nm.

[0007]

[Means for Solving the Problems] The present invention is a light-emitting diode having a light-emitting element disposed on a stem and covered by a resin mold, characterized in that said light-emitting element is made of a gallium nitride compound semiconductor represented by the general formula $Ga_XAl_{1-X}N$ ($0 \leq X \leq 1$), and a fluorescent dye or a fluorescent pigment that emits fluorescence by being excited with light emission of said gallium nitride compound semiconductor is added into said resin

mold.

[0008] FIG. 2 is one embodiment showing a structure of a LED of the present invention. There are shown a blue light-emitting element 11 having GaAlN laminated in n-type and p-type on a sapphire substrate, a metal stem 2 and a metal post 3 as in FIG. 1, and a resin mold 4 covering the light-emitting element. The back surface of the light-emitting element 11 is an insulating substrate of sapphire, and an electrode cannot be taken out of the back surface. Therefore, in order to electrically connect the n-electrode of the GaAlN layer to the metal stem 2, a technique is used by which the GaAlN layer is etched to expose a surface of the n-type layer to attach an ohmic electrode and an electrical connection is established with a gold wire. Also, the other electrode is wire-bonded on the surface of the p-type layer by means of a gold wire extending from the metal post 3, in the same manner as in FIG. 1. Further, to the resin molded 4 is added a fluorescent dye 5 that emits a wavelength having a light emission peak at 480 nm by being excited with a wavelength of around 420 to 440 nm.

[0009]

[Effects of the Invention] A fluorescent dye or a fluorescent pigment is generally excited by light of a short wavelength and emits light of a wavelength longer than the excitation wavelength. There is conversely a fluorescent pigment that emits light of a short wavelength by being excited with light of a long wavelength. However, it has an extremely poor energy efficiency and emits light only weakly. As mentioned above, the gallium nitride compound semiconductor has its light emission peak on the shortest wavelength side among the semiconductor materials used in the LEDs and, moreover, has a light emission peak also in the ultraviolet region. Therefore, if it is used as a material for a light-emitting element, addition of a fluorescent dye or a fluorescent pigment to the resin mold covering the light-emitting element allows excitation of such a fluorescent substance in the most suitable manner. Therefore, light of various

wavelength can be obtained by conversion in accordance with the type of the fluorescent dye or the fluorescent pigment, not to mention the color correction of the blue LED. Further, since the short wavelength light is converted into a long wavelength light and the energy efficiency is good, only a small amount of the fluorescent dye or the fluorescent pigment needs to be added, providing an extremely remarkable advantage in view of preventing decrease in the brightness.

[Brief Description of the Drawings]

[FIG. 1] A cross-sectional model view showing a structure of one conventional LED.

[FIG. 2] A cross-sectional model view showing a structure of one embodiment of a LED of the present invention.

[Explanation of Numerals]

11 ... light-emitting element

2 ... metal stem

3 ... metal post

4 ... resin mold

5 ... fluorescent dye